

bryos; in *A. venusta* the rosette cells may form embryos after the suspensor tier has become fully elongated.

5. On the whole, the embryogeny of *Abies venusta* agrees closely with other firs. It does not belong in one of the other genera of Pinaceae and there seems to be little in the embryogeny which would suggest the segregation of *A. venusta* into a distinct genus.

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July, 1941.

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## ANATOMY AND ECOLOGY OF AMMOPHILA ARENARIA LINK

EDITH A. PURER

During a period of three years, studies were made upon sand dune plants along the Pacific coast from Oregon to Baja California. Environmental factors were measured and a study of the anatomy of twelve species was undertaken. In the subsequent publication (Purer, Studies of Certain Coastal Sand Dune Plants of Southern California, Ecol. Monog. 6: 1-88, 1936) the genus *Ammophila* was omitted since it was not abundant in the particular areas where the instrumental work was carried on.

Although it is not a native species, *Ammophila arenaria* Link has been successfully planted as a sand binder in a number of areas and is fairly well distributed along the Pacific coast. Specimens were examined at the herbaria in the following institutions, Stanford University (D); University of California (UC); and the University of Southern California (USC): Linnton, Oregon, September, 1927, *Thompson 3881* (D); Eureka Peninsula, Humboldt County, June, 1899, *Dudley* (D); Point Arena, Mendocino County, August, 1899, *Davy and Blasdale 6046* (UC); one-half mile south of Lake Merced, San Francisco County, May, 1901, *Dudley* (D); Jazos Creek, San Mateo County, March, 1922, *Bacigalupi* (D);

Oceano, San Luis Obispo County, October, 1930, *de Forest* (USC); Hueneme, Ventura County, August, 1931, *Purer* 2213; strand at Spanish Bight, San Diego County, October, 1931, *Purer* 2311.

*Ammophila arenaria* thrives in open places where there is little or no vegetation, where the wind is severe, the insolation great, and the soil unstable. As a rule this grass, commonly known as sand reed, grows alone on the dunes, although occasionally plants such as *Franseria bipinnatifida* may establish themselves on sand held by *Ammophila*. Concerning the stabilization of moving dune areas, A. S. Hitchcock (Controlling Sand Dunes in the United States and Europe, Nat. Geog. Mag. 15: 46, 1904) states: "Many plants have been tried, but the most satisfactory is beach grass (*Ammophila arenaria* Link). This grass grows naturally upon the sand dunes of the North Atlantic coast of Europe as far south as Morocco, and of America as far south as North Carolina, and also along our Great Lakes. This is the grass which was used in reclaiming land which is now Golden Gate Park in San Francisco." The highway department of Oregon has also planted this species as a sand binder on dune areas of the coast.

The sand reed grows in large clumps to a height of two to three feet, the stems and the roots being produced at the nodes of elongated rhizomes. From each node of the rhizomes five or six roots, about twenty-five centimeters long and usually bearing many secondary roots two to three centimeters in length, are produced. The plant withstands partial covering by sand through the production of adventitious roots from the buried portions of its erect stems. The entire root system is smaller in proportion to the aerial parts than in other principal sand dune plants. The leaf blades which are long and gradually narrowed to a point, bend in all planes without breaking. The blades are mostly vertically placed, receiving the minimum amount of light; only old leaves are bent at an angle. Since the plant grows in tufts its leaf blades shade each other somewhat. In San Luis Obispo County the young leaves were found tightly rolled and the old leaves partially unrolled. Farther south, where the habitat is even more xeric, the leaves were always found tightly rolled; in northern California and Oregon the leaves were habitually partially unrolled. According to E. Pee-Laby (*Etude anatomique de la feuille des graminées de la France*. Ann. Sci. Nat. Bot. 8: 227-346, 1898) such variation is due to the relative dryness of the habitat.

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EXPLANATION OF THE FIGURES. PLATE 19.

PLATE 19. *AMMOPHILA ARENARIA*. *A*, stem, transverse section; *B*, vascular bundle, transverse section; *C*, folded blade, diagrammatic transverse section; *D*, blade, transverse section; *E*, infolded adaxial epidermis of blade showing motor cells; *F*, epidermal cells and stomata on adaxial surface of blade; *G*, epidermal layer of blade showing stoma, transverse section; *H*, sheath, transverse section; *I*, epidermal layer of sheath showing stoma, transverse section; *J*, root, transverse section.



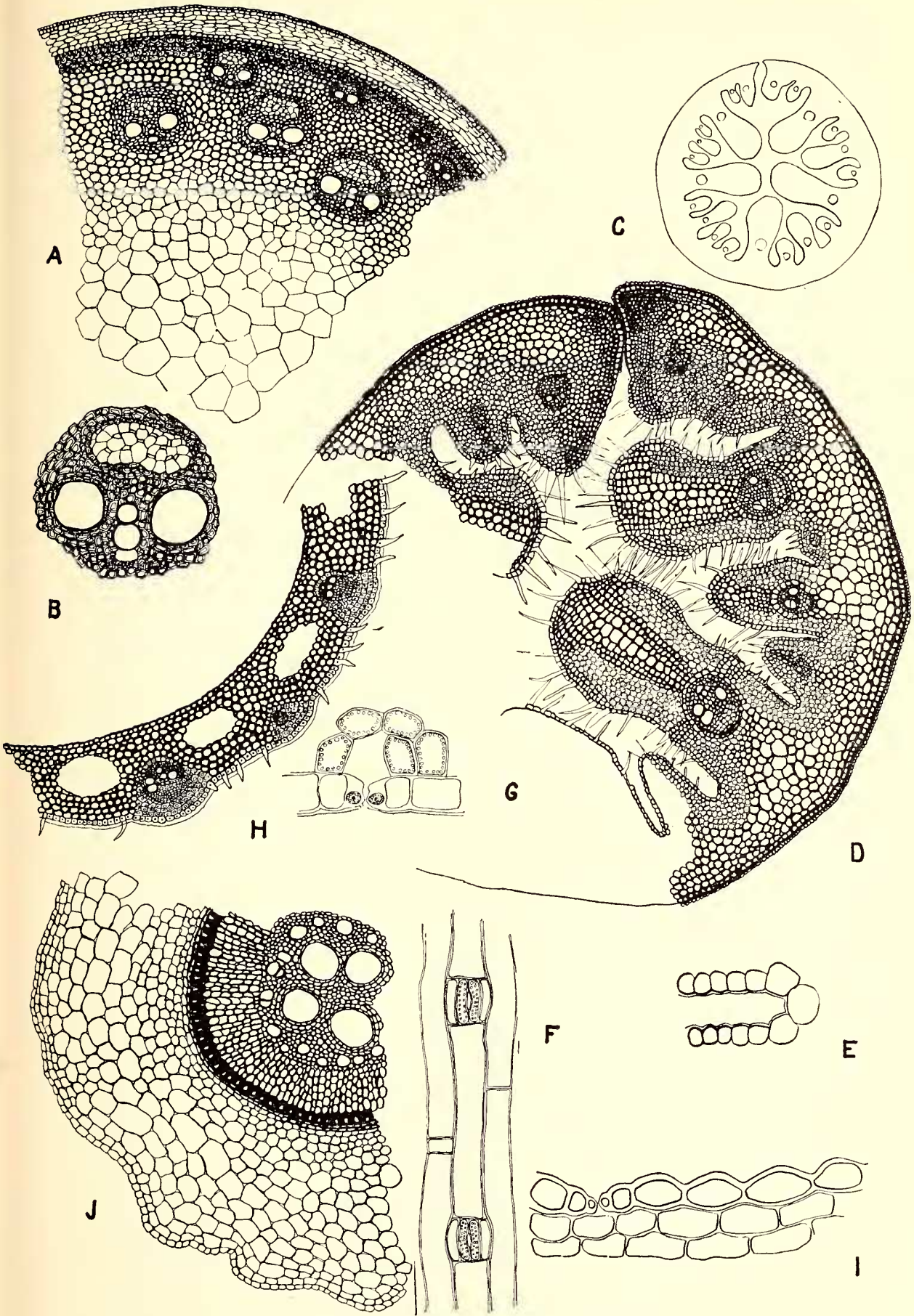


PLATE 19. AMMOPHILA ARENARIA LINK.

The roots (pl. 19, fig. J) are short and fibrous, and when pulled from the soil easily lose their outer cortical layer. The epidermis is composed of small compactly-placed cells; inside of this is the cortex, composed of soft, closely placed parenchyma cells, which makes up about two-thirds of the root in cross-section. The endodermis is composed of very heavy-walled cells, the inner wall being especially thick while the pericycle is inconspicuous. The stele contains a few tracheae surrounded by sclerenchyma. Phloem is inconspicuous.

The stem (pl. 19, figs. A, B) is of simple monocotyledonous type, compact, with few intercellular spaces, the small epidermal cells having all their walls of about equal thickness and bearing a thin layer of cuticle. Within this tissue are about five or six rows of cortical parenchyma cells and on the inner side of these a definite ring of sclerenchyma. The scattered vascular bundles are disposed in a relatively narrow zone occupying about two-fifths of the radius, the outer bundles being embedded in the ring of sclerenchyma. The central pith is definite and conspicuous, composed of large cells occupying about three-fifths of the diameter of the young stem; old stems are usually hollow.

The outside epidermis of the sheath (pl. 19, figs. H, I) is covered with thick cuticle, and bears at frequent intervals, short, unicellular, unbranched, pointed trichomes. There is a single row of closed vascular bundles with conspicuous sheaths. Sclerenchyma surrounds these, and expands to a broad, wedge-shaped mass, causing a slight protrusion of the epidermis. In the tissue between the bundles are large lacunae running vertically through the sheath. On the inner surface in parallel rows stomata occasionally occur.

The blade and sheath portions of the leaf differ considerably in structure. The cylindrically rolled blade (pl. 19, figs. C, D) of the southern California plants is covered on the abaxial surface by a firm epidermis of small cells averaging 0.017 millimeters in their radial diameter. These bear a cuticle about 0.008 millimeters in thickness, or more than 47 per cent of the radial diameter of these cells. The outer surface of the epidermis is regularly undulate, which permits the blade to unroll without splitting the cuticle. There are no stomata in this surface. Below the epidermis are several rows of large sclerenchyma cells with moderately thick walls.

The adaxial surface of the blade, the inner face of the rolled blade, is ridged and grooved. The ridges, alternately large and small, are approximately 0.55 millimeters and 0.25 millimeters in height. The epidermis here averages 0.012 millimeters in thickness, and bears abundant unicellular, unbranched, conical trichomes with thick walls, varying in length from four to ten times the diameter of the epidermis; there is a cuticle about 0.002 millimeters in thickness, or about 17 per cent of the radial diameter



of these cells. The stomata (pl. 19, figs. F, G) which are confined to the sinuses, occur in parallel rows and number about twelve per square millimeter; the stomatal pore is about 0.0014 millimeters in its long diameter, with the guard cells and the subsidiary cells measuring about 0.040 by 0.035 millimeters. The central portion of each ridge contains sclerenchyma, with a single closed fibrovascular bundle near the base of the ridge. Surrounding the grooves and extending up the sides of the ridges almost to their tops is a narrow band of chlorenchyma, which consists of small, more or less isodiametric, parenchyma cells containing numerous chloroplasts. The top of each ridge is completely filled with sclerenchyma to the point where the chlorenchyma begins. Groups of motor cells (pl. 19, fig. E) are found at the bottom of each of the grooves; the intercellular spaces are small and few. The ridged and grooved surface of the involute blade results in a withdrawal of the chlorenchyma from the light. Transpiration in the leaf is checked by inrolling, by the heavy cutinization of the abaxial surface, and by the infrequent stomata which occur only in the grooves of the inrolled epidermis where they are overlapped by the trichomes.

San Diego, California,  
February 4, 1941.

## AN UNDESCRIBED SPECIES OF CEANOTHUS FROM CALIFORNIA

HOWARD E. McMINN

*Ceanothus Masonii* sp. nov. *C. rigidus* variation 1 McMinn, Contrib. Dudley Herb. 1: 145. 1930, in part. *C. gloriosus* var. *exaltatus* J. T. Howell, Leafl. West. Bot. 2: 44. 1937, in part. Bolinas *Ceanothus*.

Frutex erectus vel erecto-patens, 6–18 dm. altus, ramis crassis arcuato-divaricatis, ramulis rigidis atro-fuscis vel purpureis, tomentulosis demum glabrescentibus; folia opposita persistentia, laminis late ellipticis vel fere orbicularibus, 6–19 mm. longis, 5–12 mm. latis, basi rotundis apice rotundis truncatisve, aliquando emarginatis, supra atroviridibus nitidis glabris, subtus albidis sub microscopio inter venas canescentibus, crebre dentatis dentibus brevibus aut rare leviter sinuato-dentatis ad basim versus integris; stipulae prominentes persistentes, 1.6–5 mm. longae; gemmae squamae fuscae glabrae vel leviter tomentulosae; inflorescentia subumbellata conglomerata, plerumque foliis binatis parvis subtentia, ramos breves (6–19 mm. longis) terminantia; flores atrocyanei vel purpurei; fructus globosus, tricornutus, 5 mm. diametro, cornibus brevibus apicalibus subapicalibusve, sine crestis intermediis instructus.

Erect or erect-spreading shrub, 6–18 dm. tall, with stout rather stiff divaricate branches and rigid dark brown or purplish tomen-